CONDITIONAL COMPOSTING OF COWDUNG, SAWDUST AND STRAW HUSK AS A TREATMENT APPROACH TO SLAUGHTERHOUSE MENACE.

ABSTRACT

Aim: The study aimed at Investigating of suitability of composting process in treatment of slaughterhouse wastes.

Study Design: The experimental set up was cylindrical bin design with C:N ratios at 30:1 each, and with turning frequencies at every 2 days intervals. Data was generated from the laboratory on the concentrations of selected heavy metals at varying depths of land discharged slaughterhouses. This was used to estimate the level of nutrient build-up in the soil within these environs.

Methodology: Fresh cow dung was collected from Omuigwe slaughterhouse at Aluu, in Ikwere Local Government Area of Rivers State using sterile water rinsed containers. About 36kg of cow dung was collected in each of the three 0.18m^3 cylindrical container. Three piles of fresh cow dung were built in a cylindrical design of diameter 0.54 m and height of 0.84 m. Each pile was turned manually using a hand shovel. The MC was measured periodically (precisely every 15 days) and turning operation was in such a way to ensure that every part is well aerated.

Results: Compost results showed high wastes volume reduction ranging from 36.67%, 66.4% and 63.3% for CD, CDSD and CDSH; also, weight reduction at the end of 90days showed a 55.51%, 67.42% and 64.38% reduction for CD, CDSD and CDSH respectively.

Conclusion: The problems of waste generated in our slaughterhouses can be better managed and corrected if proper assessment of the amount of waste generated are properly documented. This would help in accurate prediction of the best method to manage the waste generated.

Keywords: Slaughterhouse, composting processing, wood sawdust, Cow-dung, co-composting, compost.

1. INTRODUCTION

In Nigeria, nearly every town and neighborhood is provided with a slaughterhouse or slaughter slab. Ampofo and Awortwe (2017) [1] observed that slaughterhouses may be situated in urban, rural and nominated industrial sites, and that each has advantages and disadvantages. Simeon and Friday (2017) [2] also reported that, a cow brought for slaughtering produces 328.4kg of waste in form of dung, bone, blood, horn and hoof. The disposal of waste products is a problem that has always dominated the slaughter sector, and on the average, 45 percent of each live beef animal, 53 per cent of each sheep, and 34 per cent of each pig consist of non-meat substances [2]. The characteristics of slaughterhouse wastes and effluents vary from day to day depending on the number, types of stock being processed, and the processing method [3]. Clean water resources used for drinking, sustaining aquatic and terrestrial ecology, industry and aesthetic values, along with breathable air, rank as the most fundamental and important need of all viable communities. These water resources should remain within specific quality limits, and therefore require stringent and conservative protection measures. Akinnibosun and Ayejuyoni (2015) [4] reported that animal wastes can affect water, land or air qualities if proper practices of management are not adhered to. The same wastes however, can be valuable for crops but can also cause water quality impairment. It also contains organic solids, trace heavy metals, salts, bacteria, viruses, other microorganisms and sediment. The waste from animals can also be washed into streams if not protected and reduces oxygen in water, thereby endangering aquatic life. Akinnibosun and Ayejuyoni (2015) [4] also reported that improper animal waste disposal can lead to animal diseases being transmitted to humans through contact with animal feaces. Mohammed and Musa (2012), [5] reported that slaughterhouse effluents reaching streams contribute significant levels of nitrogen, phosphorous and biochemical oxygen demand, as well as other nutrients, resulting in stream pollution.

Elemile et al (2019) [6] also reported that the ground water quality in the vicinity of the slaughterhouse was adversely affected by seepage of slaughterhouse effluent as well as water quality of receiving stream that was located away from the slaughterhouse.

At sawmills, unless reprocessed into particleboard, burned in a sawdust burner or used to make heat for other milling operations, sawdust may collect in piles and add harmful leachates into local water systems, creating an environmental hazard [7].

Arimoro et al, (2006) [8] established that sawmill wood waste not only impact the water quality adversely but also alters the distribution and abundance of fish species in the locality studied. Sawdust has not been largely converted into useful purposes and the accumulation in sawmills around Nigeria constitute a high environmental hazard.

In virtually all the process industries and residential areas, solid and liquid wastes are generated. Slaughterhouse wastes can produce large quantities of malodorous gases when the entrained organic materials are decomposing and are allowed to settle, thereby rendering the vicinity offensive with pungent smell [4]. It also poses a danger to human health because it contains numerous pathogenic organisms removed from either the human intestinal tract or certain industrial waste. Slaughterhouse waste contains assorted nutrients that is suitable to aquatic life but may also be toxic. Due to the aforementioned reasons, immediate removal of slaughterhouse waste from the generation point, treatment and disposal is necessary.

Hence the need arises for a complementary treatment process that can effectively combine varieties of solid wastes materials to generate harmless/useful products. A process called composting.

Cooperband (2002) [9] expressed composting as aerobic, or oxygen-requiring, decomposition of organic materials by microorganisms under controlled conditions. The composting process is carried out by a diverse population of predominantly aerobic micro-organisms that decompose organic material in order to grow and reproduce. The activity of these micro-organisms is encouraged through management of the carbon-to nitrogen (C:N) ratio, oxygen supply, moisture content, temperature, and pH of the compost pile. Properly managed composting increases the rate of natural decomposition and generates sufficient heat to destroy weed seeds, pathogens, and fly larvae. The active composting period has three temperature ranges. These ranges are defined by the types of micro-organisms that dominate the pile during those temperatures and are called psychrophilic, mesophilic, and thermophilic. Psychrophilic temperatures are generally defined as those below 10 degrees Celsius, mesophilic between 10 and 40.56 degrees Celsius, and thermophilic above 40.56 degrees Celsius.

During composting, microorganisms consume oxygen, while feeding on organic matter. Composting transforms raw organic waste materials into biologically stable, humic substances that make excellent soil amendments.

Composting reduces both the volume and mass of the raw materials while transforming them into a valuable soil conditioner. In composting process, the amount of humus increases, the Carbon-Nitrogen (C/N) ratio decreases, pH neutralizes, and the exchange capacity of the materials increases. During composting some loss of nitrogen may occur and ammonia can escape from the composting pile. Nevertheless, composting retains most nutrients supplied by the raw materials and stores them within stable organic compounds [9].

The chemical and physical composition of waste also determines the rate of aeration required in the process, hence the use of bulking agent during composting to facilitate the free passage of air. A bulking agent is an organic/inorganic material of sufficient size to provide support and maintain air spaces within the composting matrix. Examples include woodchips (25 - 40 mm size), waste paper and peanut shells.

Aeration is important because it supplies oxygen to support aerobic metabolism, controls temperature and removes moisture, carbon dioxide and other gases. The moisture content of water hyacinth is high, thus there is need for addition of dry materials such as sawdust which acts as a bulking agent. The bulking agent absorbs the moisture to create suitable aeration within the composting mass.

The purpose of this work is to produce compost which is a soil conditioner from two materials that constitute nuisance in the environment, i.e., cow dung and sawdust. To determine the variation in the quality of compost produced, from a mix of selected species of water hyacinth and sawdust of different woods.

The Port Harcourt slaughterhouses serve the entire town, hence most of their locations beside fallow land mass have facilitated easy disposal of the wastes into soil profile without any proper treatment. This study was done to proffer solution to indiscriminant dumping of slaughter house waste materials, especially cow dung on fallow lands and shallow water bodies as a reusable treatment procedure as well as natural cure to the problems of artificial NPK used fertilizers in agricultural practices around the world.

METHODOLOGY

2.1 STUDY AREA

Appropriate study sites were selected based on the accessibility of the location and the bench mark of long term level of pollution from slaughterhouse wastes in at least a minimum of six (6) years after a general review of various slaughterhouses was conducted within the study area. A total of three (3) slaughterhouses for land discharge were analyzed. Study area was focused on Obio Akpor and Ikwere Local Government Areas of Rivers State, with estimated population of 649,600 and 265,400 respectively all in Port Harcourt, Nigeria [10]; as shown in Figure 1.

The selected slaughterhouses evaluated are as listed below;

1) Omuigwe Slaughterhouse
2) Rukpokwu Slaughterhouse
3) Rumuekini Slaughterhouse

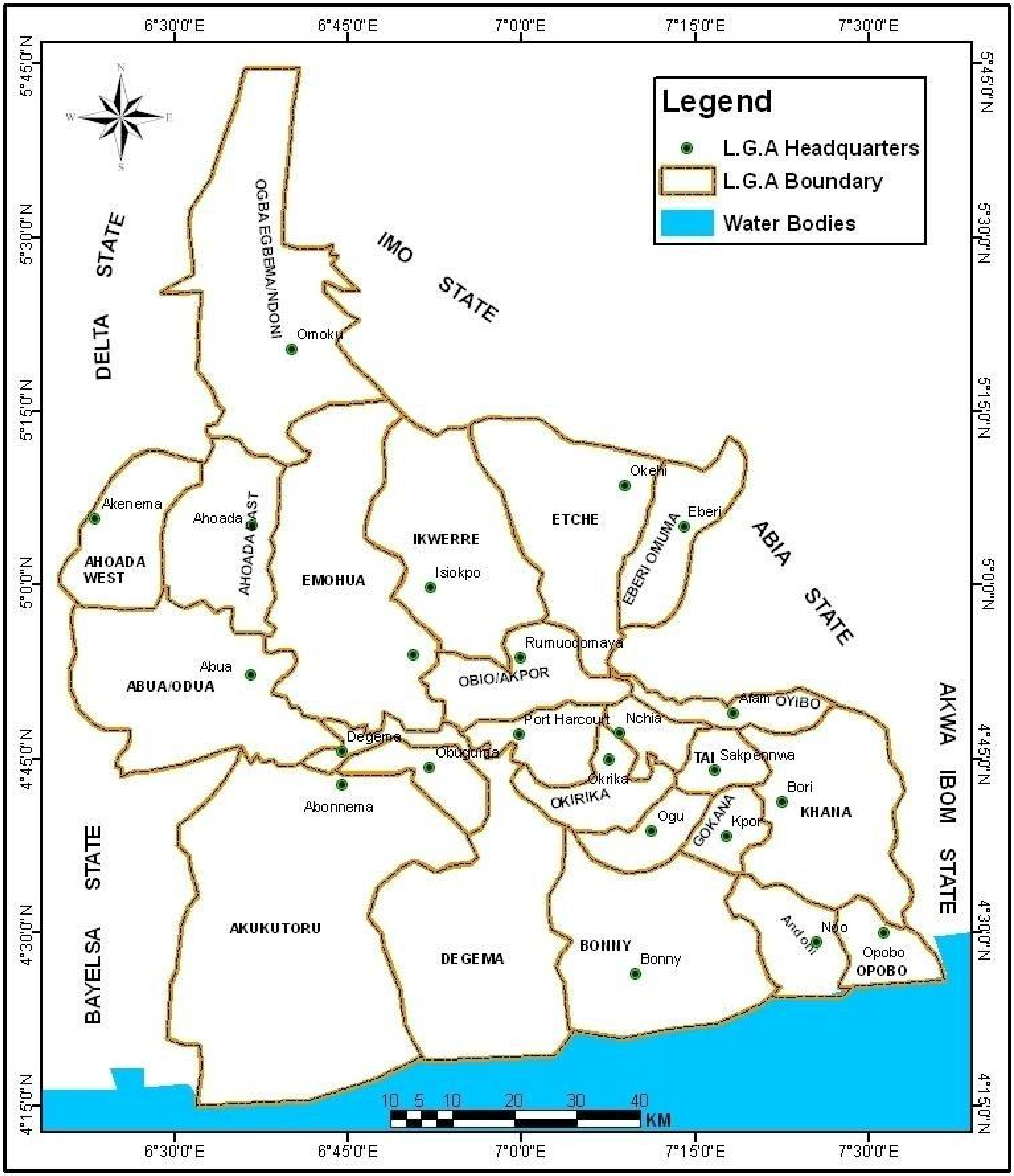

Figure 1: Map of Rivers State Showing the Local Government Areas

2.2 SAMPLE AND SAMPLING TECHNIQUES

A total of twelve composite samples were collected from three different land discharged locations. The three (is it twelve or three)composite samples each were collected from the sampling locations at a depth of 0 to 10cm, 10 to 20cm, 20 to 30cm and 30 to 40cm. Four composite samples each were collected for analysis from the three sampling locations on specified sampling dates. The samples were then placed in sterile polythene bags and transported to the laboratory for processing. Soil samples were collected from each sampling site with clean polyethylene bottles. The containers were washed with dil. HCl and then rinsed with the wastewater from the slaughterhouse so as to neutralize or reduce the effect of external contaminants. The samples were appropriately labeled and transported to the laboratory, stored in the refrigerator at 4□C prior to being analyzed for the physical, chemical and biological parameters present.

2.3 NATURE AND SOURCES OF DATA

Data was strictly from laboratory analysis of the various soil parameters being considered. The soil samples were analysed for physico-chemical parameters that included: pH, turbidity, total dissolved solids (TDS), electrical conductivity (EC), total alkalinity (TA), total hardness (TH), Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, NO^{3-}, SO_4^{2-}, Cl-, Cu^{2+}, Fe^{2+} and Mn^{2+} ions [11]. Various experimental and instrumental techniques were also employed to analyze the different chemical components.

2.4 COMPOST SAMPLE COLLECTION AND PRETREAMENT

Fresh cow dung was collected from Omuigwe slaughterhouse at Aluu, in Ikwere Local Government Area of Rivers State using sterile water rinsed containers. About 36kg of water hyacinth was collected in each of the three 0.18m^3 cylindrical container. The collection took place a day before setting up the composts in order to maintain the moisture content of the fresh dung. Saw dust was added to the mix in order to increase the surface area for microbial activities as well as easier circulation of air.

Sawdust samples were collected from Igwurita sawmill in Obio-Akpo Local Government Area of Rivers State. These were stored in aluminum foil to preserve the moisture content before mixing the following day.

TABLE 1: Initial properties of fresh cow dung and sawdust (wet weight)

PARAMETERS	%C	%N	MOISTURE	C:N ratio
Cow dung	68.77	3.74	36.8	18.39
Saw dust	54.44	0.56	23.5	97.21
Straw husk	47.29	0.86	14.1	54.99

The concentration of ash%, Total carbon (TC), Total nitrogen (TN), Carbon: Nitrogen(C:N) ratio, and moisture content (MC) of the initial composting mixture were theoretically calculated based on the results of the initial analyses. The C:N ratio of the cow dung was raised to 30:1 through the addition of sawdust and in accordance with the recommendations of Rynk et al, (1992) [11] on rapid composting.

The experimental set up was cylindrical bin design with C:N ratios at 30:1 each, and with turning frequencies at every 2 days intervals. Three piles of fresh cow dung were built in a cylindrical design of diameter 0.54 m and height of 0.84 m. Each pile was turned manually using a hand shovel. The MC was measured periodically (precisely every 15 days) and turning operation was in such a way to ensure that every part is well aerated.

2.4.1 Sampling and Analytical Procedures

During the composting process, temperatures within each pile were measured at 2 days intervals using mercury in glass thermometer. Temperature measurements were taken at the middle within the pile between the hours of 06:00 am and 08:00 am when the ambient temperature was fairly stable. Sampling was done every fifteen day from the start to the end of the experiment. Three samples each were collected at three locations in a pile (0.25 m from the top, the middle and 0.25 m from the bottom) and composited

2.4.2 Tests and Analyses of Compost Mix

2.4.2.1 Total Carbon (TOC)

Total Carbon was estimated based on the volatile solids content of the collected samples. Volatile Solids (VS) are the components (largely carbon, oxygen, and nitrogen) which burn off an already dry sample in a laboratory furnace at 500-600°C, leaving only the ash (largely calcium, magnesium, phosphorus, potassium, and other mineral elements that do not oxidize). For most biological materials the carbon content is between 45 to 60% of the volatile solids fraction (Cornell Waste Management Institute, 1996).[12] Assuming 55% gives rise to:

$$\%C = \frac{100-\%ASH}{1.8} \quad (1)$$

Where,

%VS = 100 - %Ash

2.4.2.2 Total Nitrogen

Total Nitrogen was determined using Regular-Kjeldahl method.

2.4.2.3 Carbon-Nitrogen Ratio (C:N)

C:N was determined as the ratio of Total Carbon to Total Nitrogen.

2.4.2.4 Temperature Determination

Compost temperature was determined using a 0 - 100°C glass coated mercury thermometer. A means was designed to insert the thermometer to the center of the compost.

2.4.2.5 Moisture Content

The Moisture Content (MC) of the samples was determined using oven at 105^{o}C for 24hrs.

2.4.3 COMPOST SETUP

Experimental setup was done at Elelenwo in Port Harcourt, Nigeria in an open environment to ensure a complete aerobic condition was maintained. Duration for experimental run was approximately three (3) months.

The composts were setup in three cylindrical plastic containers based on the mass ratio derived from Equation 2 and 3. The initial Carbon-Nitrogen ratio of each compost bin was adjusted to 30:1 by the mass ratio derived from Equation 2 and 3.

Figure 2: Weighing of mix ratio

Figure 3: Compost bins after setup

2.4.4 MONITORING AND SAMPLING

After setting up the composts, the following parameters were taken and recorded at two (2) days interval before turning:

- Temperature
- Mass
- Volume

Turning was adopted solely for purpose of aerating the compost. In addition to parameters highlighted above, samples were collected at fifteen (15) days interval to analyse the following parameters:

- Moisture content
- TOC
- Total Nitrogen

At the end of chosen ninety (90) days period, the collected samples were also analysed for Nitrogen, Phosphorus, and Potassium (NPK) content.

2.4.5 C/N RATIO AND MOISTURE CONTENT

One of the first tasks in developing a successful composting program is getting the right combination of ingredients. Two parameters are particularly important in this regard: moisture content and the carbon to nitrogen (C/N) ratio. The usual recommended range for C/N ratios at the start of the composting process is about 30/1, while most literature recommends a moisture content of 50%-60% by weight for optimal composting conditions [12].

The general formula for percentage moisture of compost mix:

$$G = \frac{(Q_1 \times M_1) + (Q_2 \times M_2) + \cdots}{Q_1 + Q_2 + \cdots} \quad (2)$$

Where:

G = Moisture goal of the mix

M_n= Moisture content of material n

Q_n= Mass of material n

And for C/N of the mix:

$$R = \frac{Q_1 C_1 (100 - M_1) + Q_2 C_2 (100 - M_2) + \cdots}{Q_1 N_1 (100 - M_1) + Q_2 N_2 (100 - M_2) + \cdots} \quad (3)$$

Where:

R = C/N goal of the mix

M_n= Moisture content of material n

Q_n= Mass of material n

C_n= Carbon content of material n

N_n= Nitrogen content of material n

This equation can be solved exactly for a mixture of two materials, knowing their carbon, nitrogen, and moisture contents, the C/N ratio goal, and specifying the mass of one ingredient.

2.4.6 BULK DENSITY AND FREE AIR SPACE

The bulk density (ρ_{bulk}) of organic material is the mass per unit volume of the material. It is a measure of the organic material and the air spaces in the sample and gives an indication of the ability of air to move through the material. Bulk weights above 640 kgm^{-3} do not have enough air spaces for adequate airflow. ρ_{bulk} is calculated from the bulk weight (ω_{bulk}) and Total Solid (TS). ω_{bulk} is a function of the moisture content and compaction of the organic material and is determined according to the British Standard method developed for soil and soil improvers [BS EN 13040:2000] to measure the bulk weight of the organic material.

The free air space (FAS) of the organic material is the ratio of gas volume to total volume.

$$FAS = 1 - \frac{\omega_{bulk} \cdot TS}{G.\omega_W} - \frac{\omega_{bulk}(1-TS)}{\omega_W} \quad (4)$$

Where G is the specific gravity of the solids fraction, and ω_W is the unit weight of water assumed to be 1 (Angela, 2003).

$$\frac{1}{G} = \frac{VS}{G_{VS}} + \frac{ASH}{G_{ASH}} \quad (5)$$

Where,

G_{VS}= specific gravity of the volatile solids fraction, VS

G_{ASH}= specific gravity of the ash fraction, ASH

By definition TS = VS + ASH. On a TS basis, the ash fraction can then be described by ASH = (1-VS)

2.4.7 VOLATILE SOLIDS AND MOISTURE LOSSES

In large and even medium sized composting systems it can be difficult to directly measure the mass of substrate once the composting process has started, so it is difficult to determine the mass that has been degraded to CO_2 and H_2O. For a completely mixed reactor, the ash and volatile solids percents of a sample and the original mass data can be used to calculate the volatile solids mass remaining using the following equation [12]:

$$VS_{M^t} = VS_{M^0}\frac{ASH_{\%^0} \times VS_{\%^t}}{ASH_{\%^t} \times VS_{\%^0}} \tag{6}$$

Where,

VS_{M^t} = the mass of volatile solids at time t

VS_{M^0} = the initial mass of volatile solids

$ASH_{\%^0}$ = the initial percent ash

$VS_{\%^t}$ = the percent volatile solids at time t

$ASH_{\%^t}$ = the percent ash at time t

$VS_{\%^0}$ = the initial percent volatile solids

At any point in time, the mass of water remaining in the compost can be calculated from:

$$H_2O_{M^t} = \frac{TS_{M^t} \times H_2O_{\%t}}{100 - H_2O_{\%t}} \tag{7}$$

Where,

$H_2O_{M^t}$ = the mass of H_2O at time t

$H_2O_{\%t}$ = the percent H_2O at time t

Percent reductions in VS or H_2O can be calculated using the following formulas:

$$(\Delta VS)_{\%} = 100\left[1 - \left(\frac{\frac{100 - VS_{\%0}}{VS_{\%0}}}{\frac{100 - VS_{\%t}}{VS_{\%t}}}\right)\right] \tag{8}$$

Where,

$(\Delta VS)_{\%}$ = percent reduction in VS

and

$$(\Delta H_2O)_{\%} = 100\left[1 - \left(\frac{100 - VS_{\%0}}{100 - VS_{\%t}}\right) \times \left(\frac{H_2O_{\%t}}{H_2O_{\%0}}\right) \times \left(\frac{100 - H_2O_{\%0}}{100 - H_2O_{\%t}}\right)\right] \tag{9}$$

Where,

$(\Delta H_2O)_{\%}$ = percent reduction in H_2O at time, t.

3.1 Composting Result and Discussion

3.1.1 Temperature evaluation

The variation in temperature of composting material with time is illustrated in Figures 4.

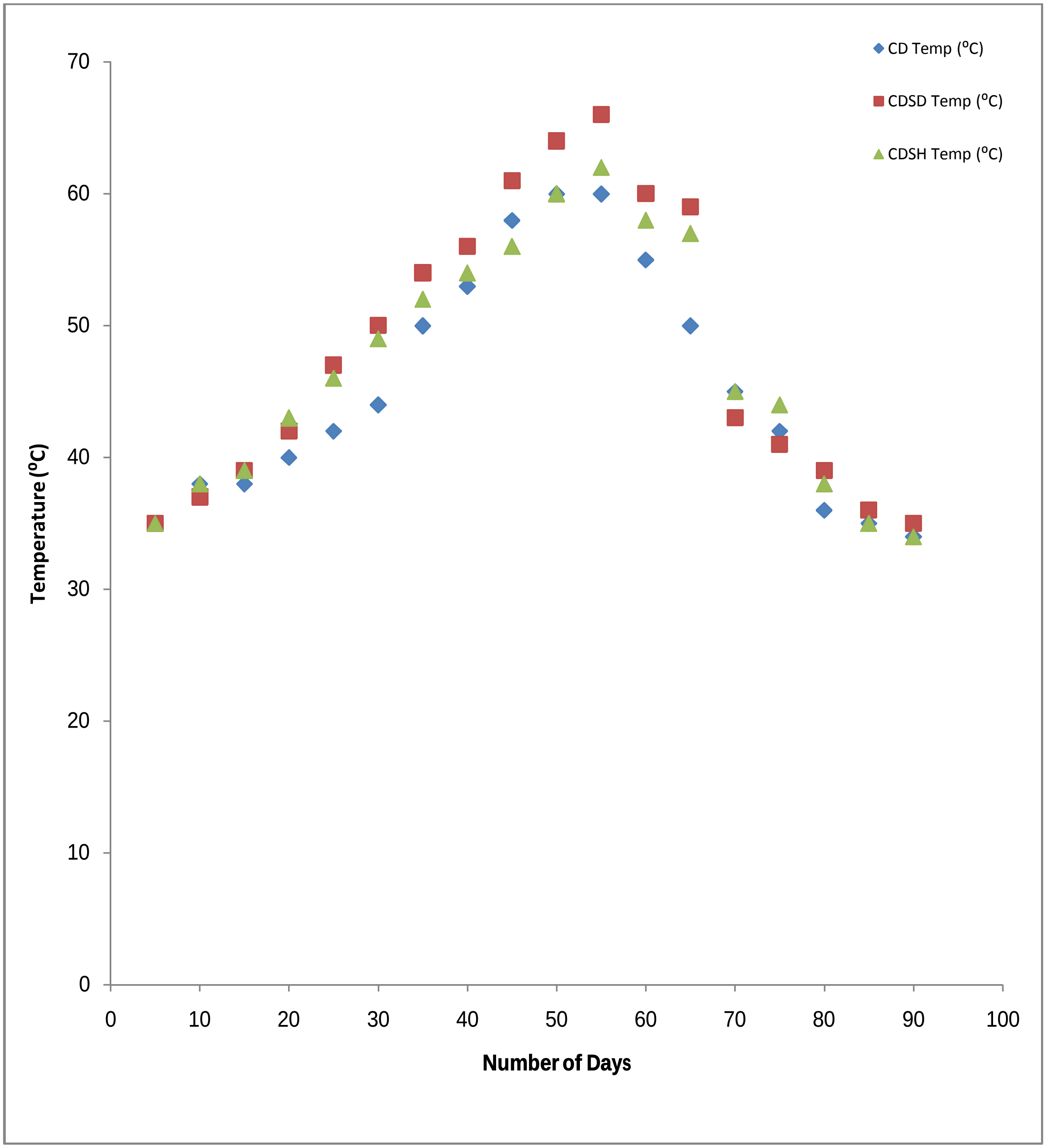

Figure 4: Temperature variations of composting mixtures

3.1.2 Volume Reduction

Volume reduction varied from trial 1 to trial 3. As a result of degradation from microbial activities, compost reduced from initial volume of 0.15(mm³) for all set-up to 0.095, 0.0504 and 0.0550(mm³) for trials 1, 2 and 3 respectively.

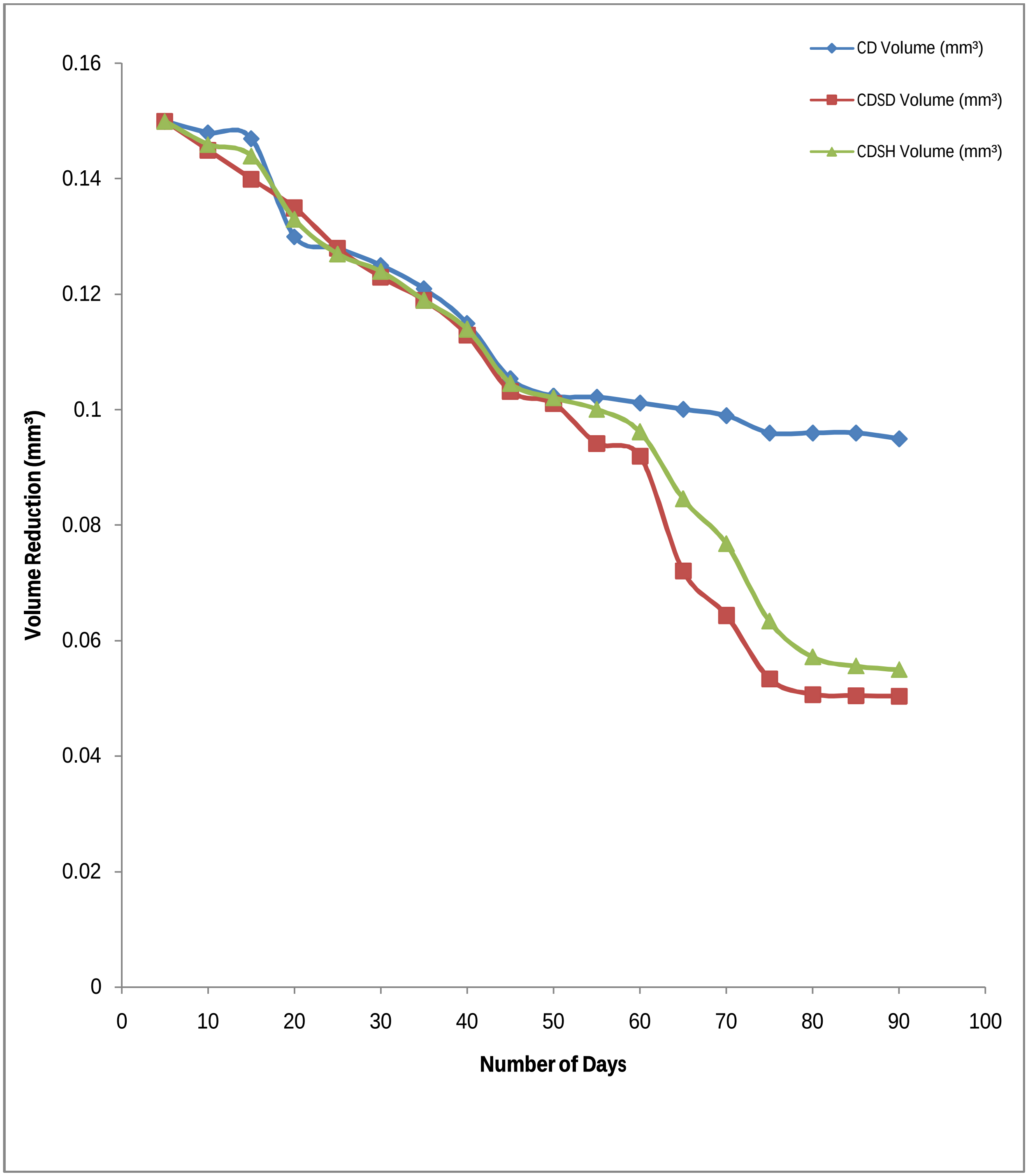

Figure 5: Volume reduction in composting mixtures

3.1.3 Weight Reduction

Weight reduction varied from trial 1 to trial 3. As a result of degradation from microbial activities, compost reduced in weight from 37.85, 37.81 and 37.84 (kg) to 16.84, 12.32 and 13.48(kg) for trials 1, 2 and 3 respectively.

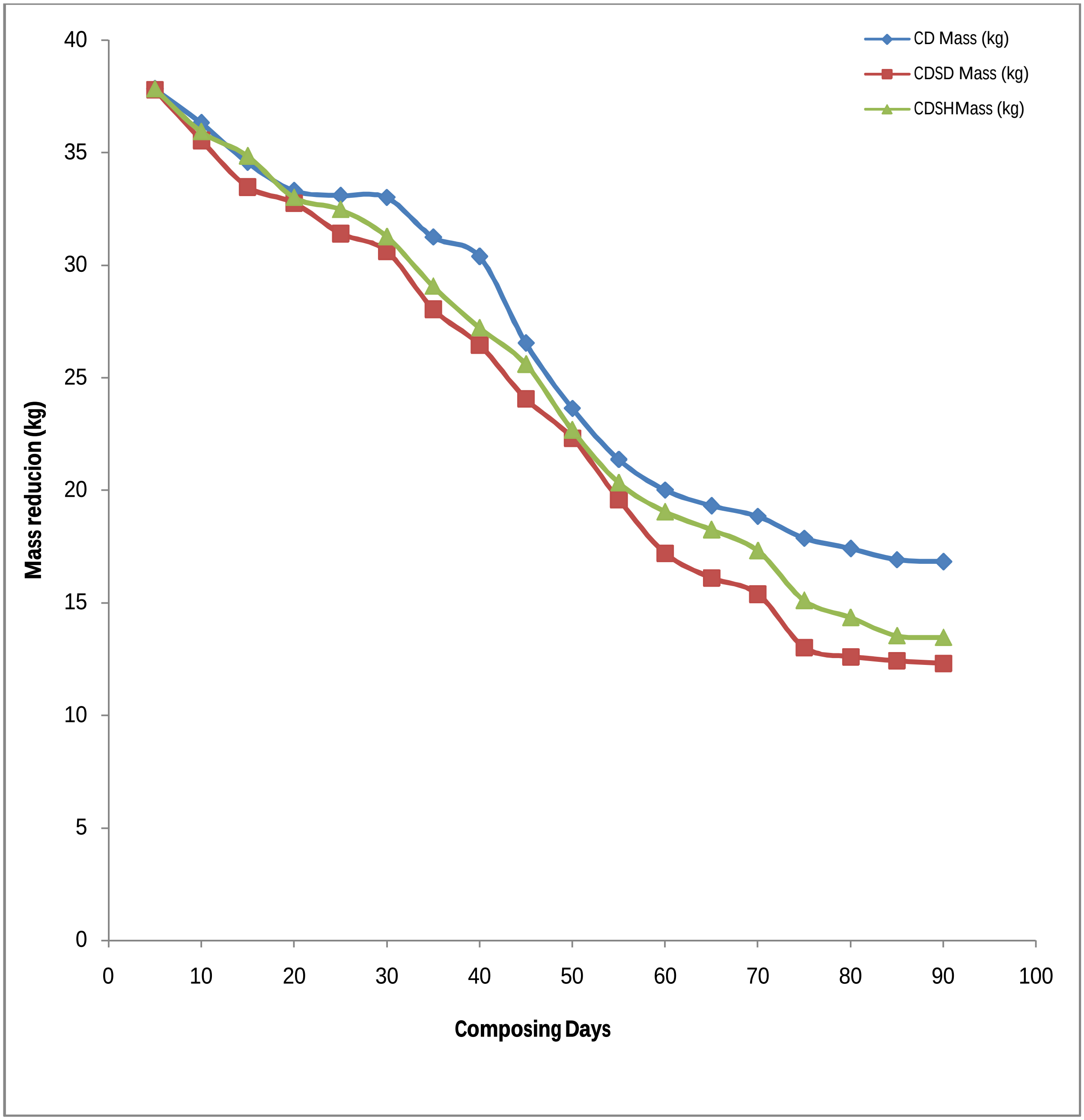

Figure 6: Weight reduction in composting mixtures.

A summary of all other compost evaluated parameters is as shown in Table 2 below;

Table 2: Co-Parameters results from composting evaluation.

Feedstock ID	**Organic Matter (%)**	**Total Ash Content (%)**	**Total Nitrogen (%)**	**K_2O (%)**	**Ca (%)**	**Mg (%)**	**Total Carbon (%)**	**C:N**
CDSD	82.26	86.32	3.89	2.64	8.37	2.57	66.23	16.88
CDSH	78.48	92.61	3.45	3.68	7.62	1.89	56.34	16.23
CD	84.16	85.28	3.06	3.52	7.96	2.48	58.46	18.94

NOTE: CD=Cow dung (Compost Trial 1), CDSD=Cow dung and Saw dust (Compost Trial 2), CDSH=Cow dung and Straw Husk (Compost Trial 3).

Table 3: Mass, Volume and Temperature results for compost piles Experimental set-up

Days	Cow Dung (CD)			Cow Dung and Saw Dust (CDSD)			Cow Dung and Straw Husk (CDSH)		
	Mass (kg)	Volume (m^3)	Temp (°C)	Mass (kg)	Volume (m^3)	Temp (°C)	Mass (kg)	Volume (m^3)	Temp (°C)
5	37.85	0.15	35	37.81	0.15	35	37.84	0.15	35
10	36.34	0.148	38	35.56	0.145	37	35.94	0.146	38
15	34.58	0.147	38	33.49	0.140	39	34.86	0.144	39
20	33.32	0.130	40	32.78	0.135	42	33.02	0.133	43
25	33.11	0.128	42	31.42	0.128	47	32.48	0.127	46
30	33.02	0.125	44	30.63	0.123	50	31.28	0.124	49
35	31.26	0.121	50	28.06	0.119	54	29.07	0.119	52
40	30.40	0.115	53	26.47	0.113	56	27.23	0.114	54
45	26.55	0.1054	58	24.07	0.1032	61	25.61	0.1046	56
50	23.65	0.1024	60	22.33	0.1011	64	22.69	0.1021	60
55	21.38	0.1022	60	19.61	0.0942	66	20.35	0.1001	62
60	20.02	0.1012	55	17.22	0.0920	60	19.06	0.0962	58
65	19.32	0.1001	50	16.12	0.0721	59	18.26	0.0846	57
70	18.85	0.099	45	15.40	0.0644	43	17.33	0.0768	45
75	17.88	0.096	42	13.03	0.0534	41	15.12	0.0634	44

80	17.42	0.096	36	12.62	0.0507	39	14.36	0.0572	38
85	16.92	0.096	35	12.43	0.0505	36	13.55	0.0556	35
90	16.84	0.095	34	12.32	0.0504	35	13.48	0.0550	34

3.2 Composting Result Analysis

All compost set up reached 60°C (maximum in all 3 trials) and enters into mesophilic phase after 20 days indicating establishment of microbial activities as shown in **Figure 4**. Low rise in temperature at the beginning of composting was attributed to higher content of non-easily biodegradable carbon. In CDSD compost bin, the initial temperature at day 5 was 35°C which further increased up to 66°C on day 55. Also, CDSH observed a maximum temperature of 62°C. The high rise in temperature showed a good C/N ratio compatibility of the compost mix materials, creating a conducive breeding environment for micro-organisms. At the evening of Day 55, we had to cool the compost experiment by sprinkling some water to ensure that the set ups do not exceed far above the recommended temperature of 60°C-65°C. Afterwards cooling period was observed until the end of the composting process.

However, higher initial moisture content of 85.6% was observed in CD due to large proportion of cow dung which further dropped to 62.05% at the end of 90 days of pile composting. Moisture content dropped to 66.10%, 65.62% respectively in trials 2 and 3. Percentage decrease in moisture content was 24.45%, 19.98% and 19.6% during trials 1, 2 and 3 respectively. This justified the higher temperature evaluation in trials 2 and 3. The moisture content of the final compost was found to be on the higher range and not within an acceptable range of 50% to 60% which may be attributed to high initial moisture in composting material i.e., cow dung. Therefore, compost should be dried in natural environment before application in the agriculture field.

Furthermore, compost experimental set-up showed high wastes volume reduction ranging from 36.67%, 66.4% and 63.3% for CD, CDSD and CDSH respectively as shown in **Figure 5.** Also, weight reduction at the end of 90days showed a 55.51%, 67.42% and 64.38% reduction for CD, CDSD and CDSH respectively as shown **in Figure 6.** This result shows the effect of saw dust (SD) and shaft husk (SH) as conditioners in building/increasing the rate of re-aeration of the compost pile, hereby helping to create a conducive environment for the microorganisms to strive. Hence, it must be noted that co-composting of cow dung with sawdust/shaft husk has proved to check the excess loss of nitrogen by transpiration from the compost pile, due to increased temperature generation [13].

4. CONCLUSION

The purpose of this work is to produce compost which is a soil conditioner from three materials that constitute nuisance in the environment i.e. cow dung, sawdust and straw husk. The purpose of this study was to determine if large scale composting was an effective means of managing cow dung wastes generated from slaughter houses. Hence, to determine the variation in the quality of compost produced, from a mix of sawdust and straw husk with appropriate volumes of cow dungs as computed using the carbon/nitrogen (C/N) mix ratio. Cow dung, saw dust and straw husk were effectively blended, to produce natural composts for agricultural and horticultural purposes.

From the results obtained in this experiment, carbon to nitrogen ratio in Cow dung, saw dust and Straw husk was carefully harmonized in a proportion to produce compost effective enough to condition our soil for agricultural purposes

For further studies on this subject, we advise that cow dung be dried before composting, to reduce the initial moisture content. At moisture level above 60% small pore spaces that allow oxygen to move into compost become filled with water. Because oxygen diffuses so much slower in water than in air, excess moisture reduces oxygen penetration.

This research work has been able to offer solution to indiscriminant dumping of slaughter house waste materials, on fallow lands and shallow water bodies as a reusable treatment procedure as well as natural cure to the problems of artificial NPK used fertilizers in agricultural practices around the world. Slaughter houses wastes can now be composted to generate varieties of natural fertilizers at different NPK ratios, which can be used as soil conditioners to enhance the nutrient deficiencies of unproductive agricultural lands with little or no side effects as compared to the artificial NPK fertilizers in use today.

REFERENCES

1. Ampofo E. A. and Awortwe D. (2017): Heavy metal (Cu, Fe and Zn) pollution in soils: pig waste contribution in the Central Region of Ghana. Adv Appl Sci Res;8:1-10.
2. Simeon E. O. and Friday K. (2017): Index models assessment of heavy metal pollution in soils within selected slaughterhouses in Port Harcourt, Rivers State, Nigeria. Singapore J Sci Res;7:9-15.
3. Abubakar G. A. and Tukur A. (2014): Impact of slaughterhouse effluent on soil chemical properties in Yola, Adamawa State, Nigeria. Int J Sustain Agricult Res;1:100-107.
4. Akinnibosun F. I and Ayejuyoni T. P. (2015): Assessment of microbial population and physico-chemical properties of slaughterhouse effluent-contaminated soils in Benin City, Nigeria. Journal of Tropical Agricult Food Environ Exten;14:1-6.

5. Mohammed S. and Musa J. J. (2012). Impact of Slaughterhouse Effluent on River Landzu, Bida, Nigeria. J. Chem. Biol. Phys. Sci. 2(1), 132-136.
6. Elemile O. O., Raphael D. O., Omole D.O., Oloruntoba E. O., Ajayi E.O. and Ohwavborua N. A. (2019): Assessment of the impact of slaughterhouse effluent the quality of groundwater in a residential area of Omu-Aran, Nigeria. Environ Sci Europ;31:1-10.
7. Texas Commission on Environmental Quality, TCEQ, (2008) Sawmill Air Quality Standard Permit
8. Arimoro, F.O., Robert, B.I., and Efe, C.O., (2006) "The Impact of Sawmill Wood Wastes on the water Quality and Fish Communities of Benin River", Niger Delta Area, Nigeria, World Journal of Zoology Vol.1 (2): p94-102
9. Cooperband, .L., (2002) "The Art and Science of Composting", A resource for farmers and compost producers, University of Wisconsin-Madison, Center for Integrated Agricultural Systems.
10. Kumar, P. and Singh, A. (2019); Groundwater Contaminant Transport Modelling for Unsaturated Media using Numerical Methods (FEM, FDM). Int. J. Recent Technol. Eng. (IJRTE), 8, 2277–3878.(7)
11. Rynk, R. M.; Kamp, G.B.; Willson, M. E.;Singley, T. L.; Richard, J.J.;Kolega, F. R.;Gouin, L.; Laliberty, D.; Kay, D. W.; Murphy, H.A.; J. Hoitink, and W.F. Brinton,(1992) "On-Farm Composting Handbook", Cooperative Extension, NewYork.
12. Cornell Waste Management Institute, (1996) "science and engineering of composting", Dept of Crop and Soil Sciences, Cornell University Ithaca, NY.
13. Cochran,B. J. and Carney,W. A. (2012) "Basic principles of composting", Louisiana State University of Agricultural Center, Research and Extension,Pub. 2622 (1M) 4/96